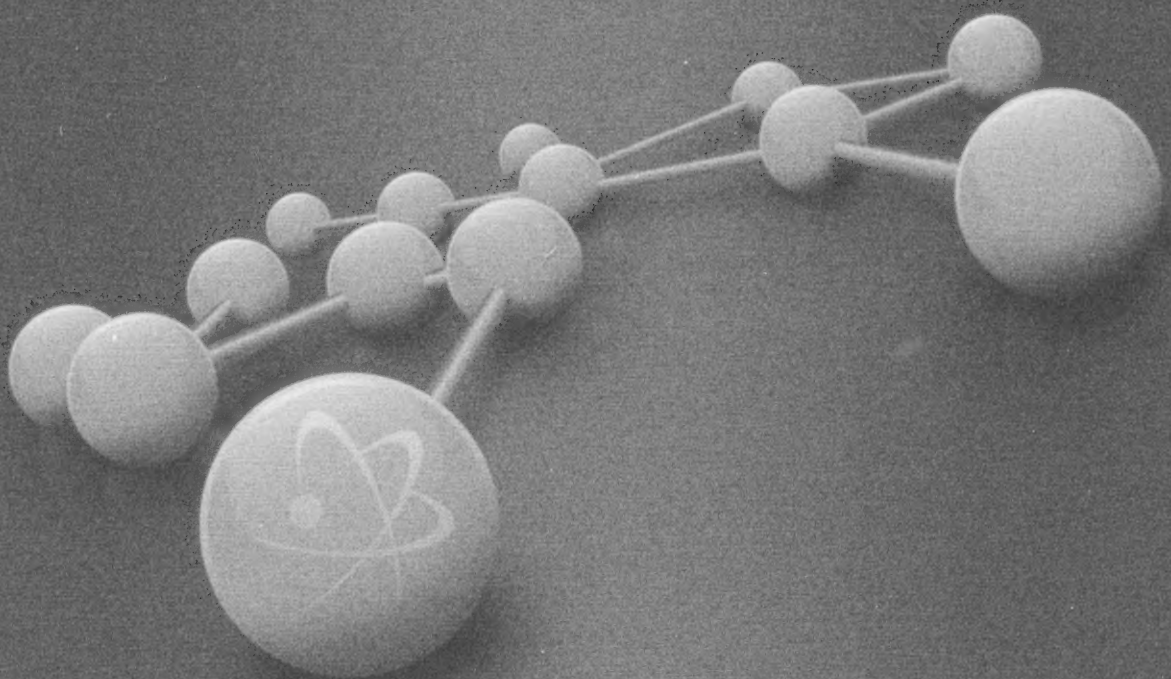
National Sealed Source Registry (NSSR) & Sealed Source Tracking System (SSTS) Annual Report 2007



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and the Sealed Source Tracking System

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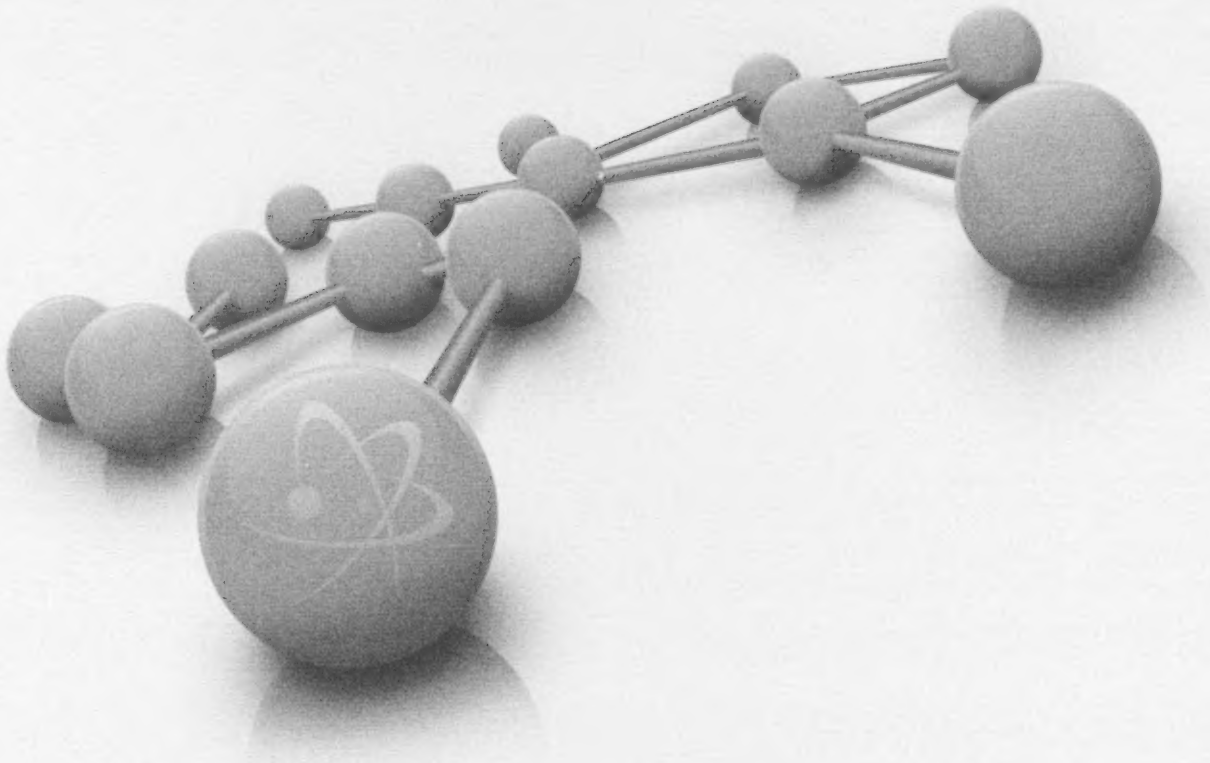


Executive Summary

This report describes developments in the Canadian Nuclear Safety Commission's (CNSC) National Sealed Source Registry (NSSR) and Sealed Source Tracking System (SSTS) for the period of January 1, 2007 to December 31, 2007. The CNSC was the first nuclear regulator among G-8 countries to develop a national registry and to implement a Web-based tracking system, along with enhanced export and import controls for high-risk sealed sources. This is the second NSSR/SSTS annual report.

The CNSC has established and implemented effective and efficient regulatory systems to ensure the safety and security of high-risk radioactive sources and devices in Canada. The NSSR and SSTS strengthen the CNSC's and Canada's controls on high-risk radioactive sources. These systems contain information on the movement and location of high-risk radioactive sources in Canada, from their manufacture to their final disposition (cradle-to-grave approach). All high-risk radioactive sources in Canada are tracked, except those under the control of the Department of National Defence, which is exempted from CNSC regulation. The CNSC designed and implemented the NSSR and the SSTS in a manner consistent with the provisions of the International Atomic Energy Agency's (IAEA) *Code of Conduct on the Safety and Security of Radioactive Sources* (the Code).

The CNSC began its project to develop the NSSR and SSTS in 2004 and 2005. The project team designed the system, developed software requirements, and accumulated initial data about radioactive sealed sources in Canada. Also, to implement the SSTS, the CNSC had to amend licences in order to make mandatory the reporting of radioactive source transactions. Accordingly, in mid-2005, CNSC staff asked the Commission to amend 278 licences listing high-risk radioactive sealed sources. Licensees were notified and consulted, and the Commission agreed to amend the licences; source tracking of high-risk sealed sources became a legal requirement on January 1, 2006.

The NSSR and the SSTS evolved in 2006 with the addition of a Web-based system for source tracking, allowing for a simplified method of secure reporting. Ongoing communication and consultation with licensees, as well as the establishment of a system of performance measures, has helped guide CNSC staff to ensure that operations are conducted in an efficient and secure manner.

Throughout 2007, the NSSR continued to be populated with high-risk source information, as licensees reported their transactions. Gradually, the NSSR is also receiving information about category 3, 4 and 5 (moderate and low-risk) sources in Canada. This information about moderate and low-risk sources is added to the NSSR as licensees submit details of their current source inventories on-line.

By the end of December 2007, the NSSR had information regarding 15,538 radioactive sealed sources of all categories in Canada. This is an increase of 8,388 over 2006. For 2007, the SSTS was tracking 3,224 sources of category 1 and 9,523 sources of category 2. The other 2,791 sources in the NSSR were category 3, 4 and 5 (moderate and low-risk), which are not subject to mandatory tracking. The SSTS registered more than 39,000 transactions of all types throughout the year, which represents a 31% increase over 2006. The increases are due to better reporting and communication tools between the licensees and the CNSC, as well as improved regulatory oversight.

Table of Contents

1 Past to present

In 2004, the International Atomic Energy Agency (IAEA) published the *Code of Conduct on the Safety and Security of Radioactive Sources*. The CNSC participated in meetings to draft the Code, and determined that source tracking, a national source registry, and source export licensing at the CNSC needed to be bridged to make Canadian practice conform to the provisions of the Code. Accordingly, the CNSC began developing projects to address these gaps, commencing with the National Sealed Source Registry (NSSR) and Sealed Source Tracking System (SSTS). The NSSR and SSTS were implemented in January 2006, and export licensing provisions to conform to the Code were implemented in April 2007.

The CNSC maintains a regulatory framework of specific licensing for all sealed sources and radiation devices. The CNSC's Nuclear Substance and Radiation Devices licences and the Class II Nuclear Facilities and Prescribed Equipment licences state the specific radioactive nuclear substance and the maximum quantity of that nuclear substance allowable for each type of radiation device. The NSSR contains the serial numbers of each high-risk radioactive sealed source, as well as specific information on the radiation device (or other type of prescribed equipment) containing the sealed source, and the location and number of devices (or equipment) of each type held by a licensee.

2 Description of the NSSR and SSTS

The SSTS is a secure information management program used to populate the NSSR, and allows licensees to report on-line source transactions. The NSSR enables the CNSC to build an accurate and secure inventory of high-risk sealed sources in Canada. The information is as current as the reporting time frames required by the licence (e.g. reporting within two days of receipt and seven days in advance of any transfer).

The NSSR contains information about the numbers and kinds of high-risk radioactive sealed sources, radiation devices and other prescribed equipment in Canada. More complete information about the moderate and low-risk sources is planned to be included in the NSSR by 2009.

Sealed sources are categorized by the IAEA[1] into one of five categories (see Appendix) with categories 1 and 2 being designated as high-risk. Currently, the NSSR contains data about all the category 1 and 2 sources (high-risk) in Canada, and data on a limited number of the category 3, 4 and 5 sources. Category 3 sources are moderate-risk, and categories 4 and 5 sources are low-risk. The CNSC has focused its efforts to accurately capture the data about high-risk (or risk-significant) sources as first priority.

[1] Categorization of radioactive sources, IAEA TECDOC-1344, 2003

3 Major developments in 2007

3.1 System design enhancements

Based on comments and suggestions received from system users, the CNSC designed and tested modifications to the secure, Web-based SSTS system in 2007. The modifications include a more user-friendly interface through the availability of drop-down listings of information, improved reference tools, and the incorporation of CNSC's new Web page design. The expected roll-out for the next version is in the first half of 2008.

3.2 Outreach program

In April 2007, the CNSC held two meetings to discuss "Regulatory Issues in Industrial Radiography". The meetings were held in Ottawa, Ontario, and in Nisku, Alberta. Both meetings discussed changes to the SSTS, and also addressed licensees' questions. One of the main objectives of the meetings was to emphasize to licensees that the system is needed for safety and security reasons, both nationally and internationally. Training on the reporting process with the systems was provided, as well as a demonstration of the NSSR and Web interface.

Individual meetings were also held with major distributors of sealed sources, to discuss issues pertaining to the use of the system and population of the NSSR.

3.3 International presentations

In June 2007, the CNSC participated in a meeting of technical and legal experts for sharing of information on the international implementation of the *Code of Conduct on the Safety and Security of Radioactive Sources*, and its supplementary *Guidance on the Import and Export of Radioactive Sources*. During this meeting, CNSC staff gave a presentation on the implementation of the Code in Canada.

In December 2007, CNSC staff participated in the GICNT Workshop (Global Initiative to Combat Nuclear Terrorism) regarding National Sealed Source Registries, in Munich, Germany, and gave a presentation regarding the CNSC's two-year experience with its Sealed Source Tracking System and National Sealed Source Registry.

4 Performance management

4.1 Establishing performance measures

In order to gauge the effectiveness of the SSTS program and the accuracy of the data in the system, the CNSC designed and implemented in 2007 a project to establish performance measures. This involves conducting inspections to physically verify licensees' inventories, source movement and locations against the information in the NSSR and SSTS. As part of this project, which will become part of the routine compliance inspection activities in 2008, random checks of data entries from licensees using the SSTS for Category 1 and 2 sources against actual licensee inventories were done to verify that real inventories matched the data entered in the SSTS. The results demonstrated that all sources in inventory for the licensees tested were accounted for in the system.

4.2 Data standardization issues

Issues identified in 2006 regarding data inconsistencies, resulting from a non-standard nomenclature in identifying radiography sealed source assemblies, were examined and further evaluated during performance evaluations and inspections in 2007. The frequency of inconsistencies is expected to be significantly reduced with the implementation of the system enhancements, referred to in section 5 of this document, which are planned for 2008.

4.3 Compliance verification

Inspection datasheets used by CNSC inspectors were modified to include the SSTS tracking requirement. CNSC inspectors will begin to use SSTS data in their inspection visits in 2008. This will provide ongoing compliance and performance evaluation of the data.

5 Forthcoming improvements and objectives

5.1 Updates and improvements to NSSR and Web SSTS

Licensees indicated that too much information has to be keyed into the SSTS Web pages, which increases the chances of errors in data entry in the system – mainly inconsistencies in data format. Although the SSTS Web interface was purposely designed to require source data to be keyed in to ensure consistency in correctly identifying the sources, the problem was corrected by creating more user-friendly drop down menus and pick lists. This was enabled with the use of the Government of Canada's e-Pass secure log-in technology to access the SSTS, which provides high level system security. This improvement, and other improvements to the user interface, such as e-mail notification, a licence lookup tool, unit converters (between SI units and non-SI units) and a decay activity calculator, was thoroughly evaluated and integrated into the version 2 of the SSTS, which is expected to be released in the first half of 2008.

5.2 Ongoing documentation

As enabling tools are created and modified, procedures will be written, revised, and added as part of the NSSR/SSTS Manual.

5.3 Population of the NSSR with Category 3, 4 and 5 sources

In late 2007, the NSSR started to be populated with data on sealed sources from categories 3, 4 and 5. This project is expected to continue through 2008 and be completed in 2009. Once complete, the NSSR will contain complete data on all categories of sealed sources in Canada.

6 Statistics

These statistics encompass the entire National Sealed Source Registry and Sealed Source Tracking System. The data includes all sources reported by mail, fax and e-mail, as well as Web transactions (transfers, receipts, imports, exports, cancellations, changes, and creations).

Table 1: National Sealed Source Registry Statistics

	NSSR Statistics	As of Dec 31, 2006	As of Dec 31, 2007
1	Number of NSSR transactions[2]	30,167	39,645
2	Number of sources in NSSR (all categories) in Canada	7,150	15,538
3	Number of category 1 sources tracked in Canada	1,638	3,224
4	Number of category 2 sources tracked in Canada	3,920	9,523
5	Number of category 3 sources recorded in the registry	995	1,186
6	Number of category 4 sources recorded in the registry	500	1,312
7	Number of category 5 sources recorded in the registry	97	293

All category 1 and 2 sources are subject to mandatory source tracking. Some category 3, 4 and 5 sources have been reported by licensees as an integral part of their overall inventory. This number has increased for 2007 as more licensees' inventories are added to the system. Also, the large increases in the number of category 1 and 2 sources from 2006 to 2007 is explained by data entry problems which were experienced at the time, as noted in section 5 above. These problems were corrected, and the 2007 figures represent more accurate data.

Phase II of the NSSR/SSTS program will add the sources in the current CNSC licensing operations database and from licensees' reported inventories for category 3, 4 and 5 sources into the registry. This will be completed by the end of 2009.

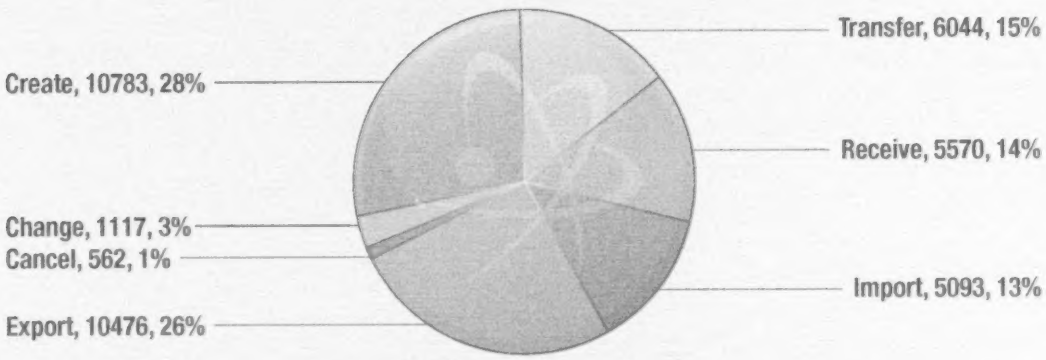
[2] This number represents all transactions for the NSSR and SSTS systems, including new sources added by manufacturers, as well as imports and exports.

Table 2: Sealed Source Tracking System Statistics

	SSTS Statistics	As of Dec 31, 2006	As of Dec 31, 2007
8	Number of NSSR transactions[2]	30,167	39,645
9	Number of SSTS transfers[3]	3,921	6,044
10	Number of SSTS Web transactions[4]	368	873
11	Number of sources that were imported into Canada	3,846	5,093
12	Number of sources that were exported from Canada	6,945	10,476

Chart #1: Chart of Transactions by Type:

NSSR Transactions by Type, January to December 2007

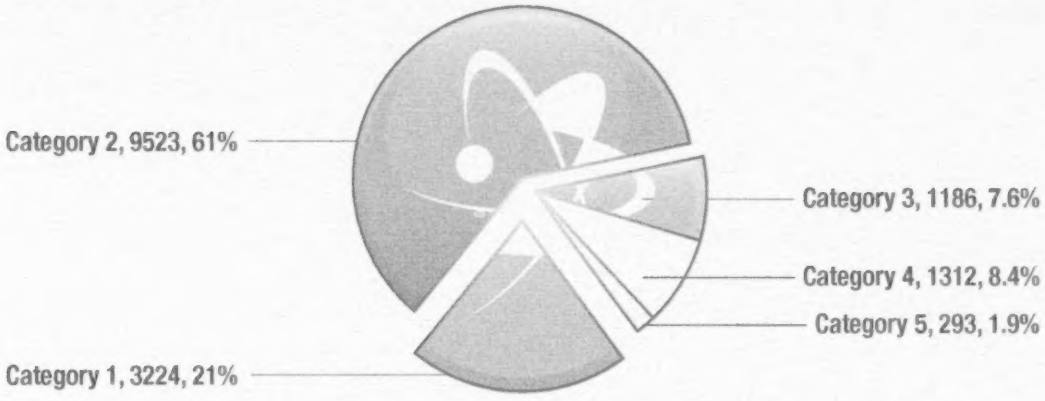


Create:	creation of a new source manufactured in Canada
Change:	data change (e.g. to reference date or source activity)
Cancel:	data change due to unforeseen circumstances (export and shipment cancellations and delayed transfers)
Export:	represents sources shipped out of Canada
Import:	represents sources shipped into Canada
Receive:	represents sources received by licensees at licensed locations
Transfer:	represents the number of sources transferred within Canada, between licensees and licensed locations

[2] This number represents all transactions for the NSSR and SSTS systems, including new sources added by manufacturers, as well as imports and exports.
[3] This number represents the number of sources transferred within Canada, between licensees and licensed locations.
[4] This number represents the number of source transfers within Canada, as conducted by licensees using the on line Web tool. The difference between lines 9 and 10 represents the number of transactions conducted by phone, fax, mail and e-mail.

Chart #2: Number of Sources by Category:

Number of Sources by Category, as of December 31, 2007
(Not Including Exported Sources)



7 Conclusion

The tracking system contains information on the movement and location of high-risk radioactive sources in Canada, from their manufacture to their final disposition. The CNSC is the first nuclear regulator among the G-8 countries to implement Web-based NSSR and SSTS systems. This enhancement in CNSC regulatory oversight demonstrates that the CNSC exercises tight regulatory control over high-risk radioactive sources. The CNSC is working on enhancing the existing system with an upgrade to the SSTS Web pages, on population of the NSSR with additional information about Category 3, 4 and 5 sealed sources, and the development and implementation of performance verification processes. Statistics show a 31.4% increase in the number of radioactive sealed source transactions, which indicates an improvement in the NSSR and SSTS systems' effectiveness and efficiency. This number is expected to increase in 2008 when more sources in categories 3, 4 and 5 are included in the registry.

Appendix

Categorization of sources

Radioactive sealed sources are used throughout the world in medicine, industry, agriculture, research and education, and vary widely in radiological risk[5]. In 2005, the IAEA published a risk-based ranking of radioactive sources and practices, which uses five categories. The category assigned to each practice or radioactive nuclear substance (which the sealed source is made of) takes into consideration factors such as the radiological risk associated with the source, the nature of the work (or application for which the source is used), the mobility of the source, experience from reported accidents, and typical vs. unique activities within an application. These factors were used to assign sources and practices to one of five categories. Category 1 sources are considered to pose the greatest risk to human health (if not managed safely and securely), while Category 5 sources pose the lowest risk.

Category 1 sources are classified as "personally extremely dangerous".

Category 1 (Very High-risk)
This amount of radioactive material, if not safely managed or securely protected, would be likely to cause permanent injury (in some cases, be fatal) to a person who handled it, or was otherwise in contact with it for a period of a few minutes (or be fatal if close to it in an unshielded manner for a few minutes to an hour).[6] Category 1 sources are associated with licensed activities to which the CNSC *Class II Nuclear Facilities and Prescribed Equipment Regulations* mostly apply.

Examples of a Category 1 source usage:

- **Self Shielded Irradiators:** Gamma sources are used in these irradiators for experimental purposes or as a means of sterilization. Gamma irradiation kills bacteria by breaking down bacterial DNA and inhibiting cell division. Blood products, for example, are sterilized in self-shielded irradiators.

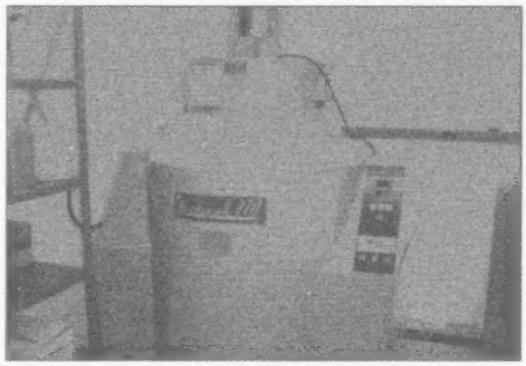


Image #1: Cobalt-60 Gammacell.

[5] IAEA, Categorization of Radioactive Sources, RS-G-1.9, (2005), p.1
[6] IAEA, Categorization of Radioactive Sources, RS-G-1.9, (2005), Table 3

- ***Gamma Knife* Radiosurgery:** An advanced form of surgery, performed with highly focused beams of radiation. As many as two hundred and one radioactive sealed sources create intersecting beams of gamma radiation which deliver a concentrated dose of radiation to a precise area of the brain. These radiation beams form the "knife".

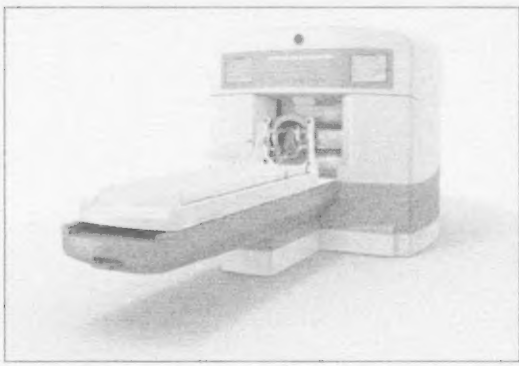


Image #2: Elekta *Gamma Knife*

Image #3: *Gamma Knife* in use

- **Radioactive Source Teletherapy:** External beam radiotherapy otherwise known as "teletherapy" is the most frequently used form of radiotherapy. Radiotherapy – is the medical use of radiation (produced by a radioactive sealed source mounted inside the machine) as part of cancer treatment, to control malignant cells.

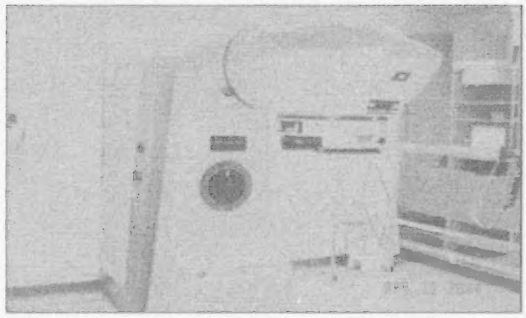


Image #4: Co-60 Teletherapy

Category 2 sources are classified as "personally very dangerous".

Category 2 (High-risk)

This amount of radioactive material, if not safely managed or securely protected, could cause permanent injury to a person who handled it, or was otherwise in contact with it for a short period of time (minutes to hours) – or be fatal if close to it in an unshielded manner for a few days. Category 2 sources are associated with licensed activities to which the CNSC *Nuclear Substances and Radiation Devices Regulations* mostly apply.

Example of a Category 2 source usage:

- **Industrial radiography** is a non-destructive testing (NDT) application that uses gamma radiation from a highly radioactive source, and photographic film, for the detection of internal physical imperfections (such as voids, cracks, flaws, segregations, porosities and inclusions) in pressure vessels, pipelines, ships and reactor components. Radiography produces images on photographic film, similar to X-ray images, that show varying densities according to the amount of radiation absorbed in the material.

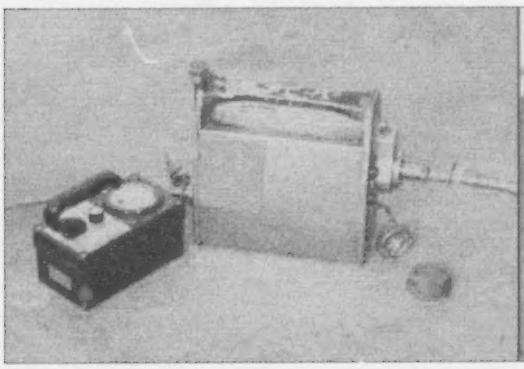


Image #5: Industrial radiography camera which contains the radioactive sealed source

Image #6: NDT pipeline inspection, using industrial radiography equipment

Category 3 sources are classified as "personally dangerous".

Category 3 (Moderate-Risk)
This amount of radioactive material, if not safely managed or securely protected, could cause permanent injury to a person who handled it, or was otherwise in contact with it, for some hours. It could possibly — although it is unlikely — be fatal to be close to this amount of unshielded radioactive material for a period of days to weeks.[7] Category 3 sources are associated with licensed activities to which the CNSC *Nuclear Substances and Radiation Devices Regulations* mostly apply.

Examples of a Category 3 source usage:

- **Industrial gauges:** These gauges are usually installed in fixed positions for measuring and process control purposes. These include density gauges, level gauges, belt mass meters and thickness gauges. The radioactive sealed source is mounted inside the gauge and projects a radiation beam, through the material, which is picked up by a detector to provide a measurement.

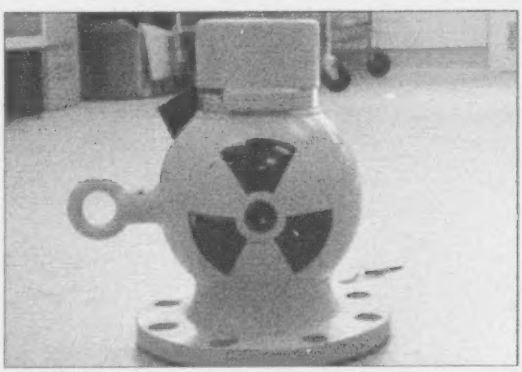


Image #7: Industrial fixed gauge

[7] IAEA, Categorization of Radioactive Sources, RS-G-1.9, (2005), Table 3

- **High dose rate (HDR) brachytherapy** is the placement of a small, highly radioactive sealed source, directly into cancerous tissues, for a short period of time. The procedure is sometimes guided by ultrasound or 3D computerized mapping techniques. Brachytherapy delivers a concentrated dose of radiation to cancerous tissue from within.

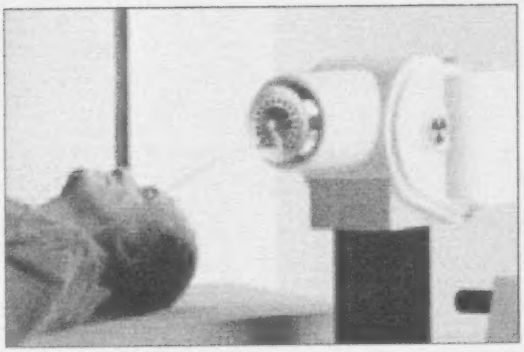


Image #8: HDR Brachytherapy

Category 4 sources are classified as "unlikely to be dangerous".

Category 4 (Low-risk)

It is very unlikely that anyone would be permanently injured by this amount of radioactive material. However, this amount of unshielded radioactive material, if not safely managed or securely protected, could possibly — although it is unlikely — temporarily injure someone who handled it or was otherwise in contact with it, or who were close to it for a period of several weeks.[8] Category 4 sources are associated with licensed activities to which the CNSC *Nuclear Substances and Radiation Devices Regulations* mostly apply.

Example of Category 4 source usage:

- **Low dose rate industrial gauges**, such as moisture/density gauges, are used to measure the density of asphalt, soil, aggregate or concrete, as well as the moisture content of soil or aggregate.

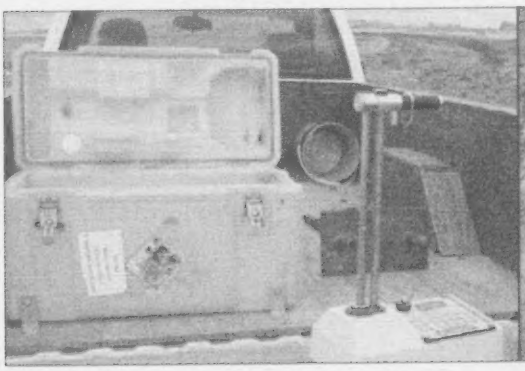


Image #9: Portable gauge

Image #10: Portable gauge in use

[8] IAEA, Categorization of Radioactive Sources, RS-G-1.9, (2005), Table 3

Category 5 sources are classified as "not dangerous".

Category 5 (Very Low-risk)
No one could be permanently injured by this amount of radioactive material.[9] Category 5 sources are associated with licensed activities to which the CNSC *Nuclear Substances and Radiation Devices Regulations* mostly apply.

Examples of a Category 5 source usage:

- **Electron capture detector Ni-63 sources**, used in gas chromatography instruments. They are used to detect minute amounts of chemical compounds, such as halogenated organic chemicals in environmental samples. Pesticide levels in foodstuffs, for example, are measured with these detectors.

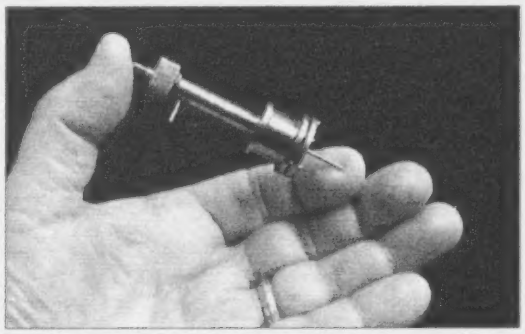


Image #11: Electron Capture Detector

- **Low dose rate (LDR) brachytherapy** involves exposure to small radioactive sealed sources for hours to days. Ocular melanoma is one example of a tumor that can be treated with LDR brachytherapy. In another example, radioactive seeds of iodine-125 are surgically implanted to treat prostate cancer.

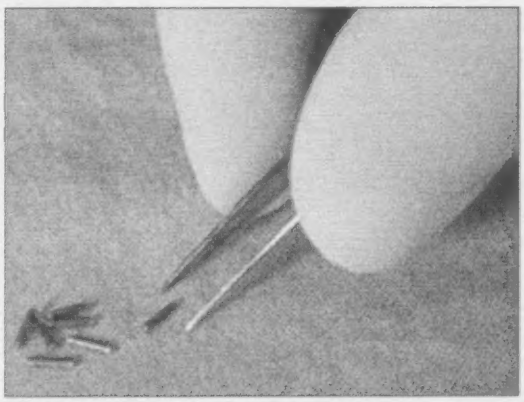


Image #12: LDR Brachytherapy

[9] IAEA, Categorization of Radioactive Sources, RS-G-1.9, (2005), Table 3

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